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Remarks

The Examiner's assertions in support of the maintenance of the final rejection set forth in the Advisory Action of 02.05.02 are respectfully traversed.

Objective facts and arguments are hereby submitted to highlight facts, apparently not considered, or fully considered by the Examiner and which are believed to support, on proper balance, the non-obviousness of the invention as claimed in claims 15-35, pending in the application.

Objective facts and evidence indicative of the actual content of the prior art and of the differences between the prior art and the claimed invention

Arima was considered by the Examiner as the basic reference.

In the following analysis, Arima is assessed in its entirety, as a whole, properly including also the teachings that lead away from the claimed process (steps) of the invention.

For immediate reference, each one of the intended use definition captioned as (a), and steps of main claim 15, captioned as (b)-(f), is followed by the indication of the step disclosed by Arima and alleged as equivalent in the final rejection, and by the indication of the objective facts which, in the applicant's opinion, makes such alleged equivalence improper.

In the following, explicitly recited limitations in the claim are properly read and interpreted in the light of the specification.

No reliance on the specification to impart to the claim limitations not recited therein has been made.

Claim 15 is directed to :

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A method

(a) for increasing the bearing capacity of foundation soils for built structures,

Arima teaches a method "for restoring unevenly settled buildings" by lifting the buildings through and only through the upward pushing effect of the hydraulic pressure provided by a non-expandable composition.

The steps of the claimed invention clearly show significant manipulative differences with respect to the process steps taught by Arima, both if taken in combination, as a whole, and specifically.

Arima teaches, in particular, restoring/lifting buildings by injecting at the bottom the foundation (see the translation at page 5, par. [0006], lines 2-3 from the bottom and page 12, par. [0019]) a flash setting grout based on cement, gypsum soda silicate and water, while generically, other, different grout compositions are indicated as usable but only "suitable for varying the gel time", i.e. the moment when the substance changes drastically the viscosity and never to change its characteristics to that of an expandable composition (see the translation at page 13, par. [0021]).

Clearly, Arima neither teaches or suggests an expanding composition nor a possible use of a strong expansion effect of an expanding composition.

Accordingly, the whole method of Arima appears to be based only and only on hydraulic pressure injection with hydraulic pressure lifting effect and subsequent hardening of a fluid which has no expansion properties whatsoever.

The hydraulic pressure is taught to be adjusted depending on the weight of the structure to be raised (see page 13, last three lines of par. [0022]) to obtain the desired restoring.

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Nowhere in the text of the translation it is specified or implied that the fluid injection effect is other than that of a pressure "force - injection" exerting a hydraulic pressure with a jack effect.

Eventually, the injected fluid "solidifies" or "hardens" to provide a horizontal, circular "reinforced" layer of soil and, thereafter, a further injection made at a pressure such as to overcome the weight of building, act upwards and lift it is carried out. The reinforced layer 31 is said to be gradually expanded due to the subsequent, additional mass of substance injected and hardened in it and not due to any chemical expansion of the substance itself (see for example in the translation pages 15-16, par [0026], lines 5-7 and lines 3-5, respectively; page 17, par. [0028] lines 5-7; par. [0029] and page 21, par. [0035]).

It is known from the cited prior art (see Eijsterveld -EP-A-264 998), that a cement based composition, only has an expansion effect, ("in the order of 25% of linear expansion", i.e. at the most 95% in volumetric expansion, which is very low if compared with that claimed in the invention of "*at least five times the volume before the expansion*", i.e. at least 500%) if it comprises a particular additive, which is the "C.S.A. - Calcium Sulpho-Aluminate".

Arima neither teaches addition of such a substance nor hints to at any desirability of achieving in some, even non specified way, a chemical reaction expansion effect.

In contrast, the claimed invention expressly excludes use of cement-based injection compositions (see specification page 2, lines 22-26) and hydraulic pressure lifting (page 6, lines 9-10).

A specific new use is thus claimed by the applicant, defined by different, new process steps carried out through injection treatment of the "foundation soil" with a highly expanding composition and real time detection of the soil level, resulting in clear-cut **manipulative differences** with respect to Arima, as follows.

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...the method comprises:

(b) providing a plurality of holes spaced from each other deep in the foundation soil;

From the specification and drawings, from the amendment based on the common, technical knowledge (see the submission "CED-148. Foundation Movements") entered on March 16, 2001, it is readily derivable for the person skilled in the art that the holes for injection are provided deep in the foundation soil, i.e. at depths selected as a function of, and related to the extension of the soil portion enclosing the "bulb of pressures", generally defined in the pertinent art as extending under the foundation for a depth being at least twice the width of the overlying foundation supporting the static and dynamic loads.

Arima teaches locations of the injection points arranged under the foundation bottom, **always at the foundation bottom level**, and is silent on possible in depth location, away from such foundation bottom and *"deep into the foundation soil"*.

Accordingly, the **depth locations** and number of injection points of Arima are imposed and consequential to the dimensions (width and level) and to the rigidity of the built foundation (see pages 11-12, last 4 lines to first 8 lines- par. [0018]).

Only the number of injection points (corresponding to the number of "injection rods"), **always arranged on horizontal planar locations at the bottom of the foundation**, the injection pressure and flow rate are taught to be determined as a function of the structure load, since the restoring pushing force is of a mere hydraulic type (see paragraphs [0018] and [0022] and [0024] of the translation) and excessive and uneven stresses on the injection rods and foundation, **occurring typically in hydraulic pressure raising operations** have to be avoided.

Note in this respect that injection points are only disclosed which are located at rod ends situated **"at the bottom of a foundation 2"** (page 1, second paragraph, page 2, lines 2-3, page 5, last three lines, page 6, lines 5-6 from the bottom of the page, page 12, par.[0019] and related figures 1-3), i.e. **immediately under the foundation of the building**.

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The cobblestone layer mentioned by the Examiner in the par. 6 of the Final Action of 11/21/2001 appears to be an artificially built layer arranged at the bottom of the foundation in a sandy (see page 14, par. [0023], 4-th line in conjunction with par. [0017]) soil.

As for the paragraph of page 20 of the translation, indicated by the Examiner in the Advisory Action of 02/05/2002 as allegedly meeting the limitation of the claims "deep in the soil", it is respectfully submitted that on proper interpretation of the whole paragraph and in the context of the method it is clear for the person skilled in the art that such paragraph indicates an embodiment of the method of Arima in which an "excavation deep in the soil" for providing locations for deep anchors (in fact piles) 20 is performed (see at page 20 of the translation, par. [0033]).

In this variant of the restoration method, Arima still teaches injections to be performed at the same foundation bottom layer 31 (see the first 6 lines of par. [0035].

A second injection, when performed is performed at the same points, distributed into a horizontal plane under the bottom foundation (as in figure 2 of Arima) and to crack into the same previously injected layer 30 which formed a circular, horizontal circular solidified layer 31 (see pages 15-16, par. [0026-0027 of the translation].

c) injecting into the foundation soil, through said holes, a substance which expands as a consequence of a chemical reaction;

Arima never teaches, as set forth above, a composition expandable through chemical reactions, its use, or at least desirability to use such a composition for injection in the method disclosed.

The substance taught by Arima is merely a flash setting composition whose pushing effect is only due to the hydraulic pressure (see for example the explicit reference to the diffusion of the injected composition occurring horizontally and to the composition of the injected substance, mentioned above in relation with the pages 15-16, and paragraphs

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[0021], [0028], [0029] and [0035], cited above for indicating the lack of expansion, respectively.

d) producing compaction of the foundation soil contiguous to the injection zone due to the expansion of said substance injected into the soil;

It clearly appears from the above indicated paragraphs that there is no "**compaction**" step in Arima "**due to the expansion of the substance injected**", inasmuch as there is no expansion of the injected substance.

e) constantly monitoring level variations of the soil and/or built structures overlying the injection zone to detect the moment when the built structures and/or the soil surface, overlying said injection zone, begins to raise which is the moment in which the compaction of the soil has reached levels generally higher than a required minimum value at which the soil lying below and around said injection zone withstands and rejects dynamic and static weights exerted thereon by said built structures and by overlying and adjacent soil masses,

The "monitoring...to detect..." step has clearly the significance of performing an operation intended to watch,... to uncover, to reveal (Webster's Unabridged Dictionary) a level variation as a **warning on the reaching of a compaction level of the foundation soil insuring that degree of bearing capacity thereof suitable to provide rejection of the overlying loads, hence appropriate support for them.**

Such monitoring/detection operation involves a **continuous, real-time process** step.

This operation represent a new way for accurate and timely assessment of the degree of **expansion of the composition, of the compaction, and of the related level of bearing capacity achieved in the foundation soil, all being "hidden developments", occurring "in depth" into the foundation soil.**

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The validity of the indication detected through the monitoring/detection step on the reaching of the required bearing capacity of the foundation soil, as claimed, has only been otherwise confirmed through penetrometric tests in the treated foundation soil, as indicated in the last two pages of the specification of the claimed invention.

This is nowhere disclosed in the cited prior art neither by Arima nor by any other of the cited prior documents, which only teaches/teach measuring raising extents exposed to visual assessment.

Arima teaches a direct visual assessment process step, i.e a "measuring step", intended to estimate, ascertain the extent, quantity, dimensions... (Webster's Unabridged Dictionary), of the lifting of the structure or of the floor in view of reaching the restoration.

Such measuring step is inherently carried out (in view of the sequential character of the injection step as disclosed in the first part of par. [0029]) **discontinuously and repeatedly**, and is intended to ascertain at distinct moments and at various points of the structure through the **physical act of measuring** the lifting amount as being, for example, a fraction of a, or a foot, two feet etc, indicating eventually if the restoration is sufficient or not.

In this connection, it is respectfully submitted that on careful and proper interpretation of the context of the disclosure of Arima, the term "rising rate", pointed out by the Examiner in the Advisory Action as possibly indicating an operation equivalent to monitoring/detection, appears to have in fact the meaning of "amount, quantity or extent of rising" which is measurable as a length. A measuring operation however, cannot lead to the detection of a moment, but only allows to "measure a length or amount of raising in a phase or in various phases of the (progress of the) operation. This is in fact indicated in the last lines of par. [0029] of the translation.

It is further submitted that such interpretation is also consistent with a second available translation of the original, Japanese text of Arima, downloaded from the website of the Japanese Patent Office, and which at page 4, in the third line from the end of the

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par. [0029] gives for the same operation the interpretation "The amount of elevation... is measured...".

This second translation is herewith enclosed as evidence.

f) the expansion of the injected substance is very fast with a potential increase in volume of the expanded substance being at least five times the volume of the substance before expansion.

Arima discloses a **non expanding** substance in a restoring process based exclusively on hydraulic pressure raising effect (see indication of the relevant facts and evidence above) while it is **completely silent on a possible utilisation of an expanding substance with an expansion, non hydraulic effect.**

Regarding the other cited prior documents on which the Examiner relied for the final rejection, it will be noted that **Schmidt et al (US 4904125)** do not disclose or suggest using expanding compositions with volume expansions of at least, and more than 500% for injection into, and under structure generating a, foundation soil mass, and a monitoring/detection step as claimed by the applicant.

Bijsterveld et al (EP-A-264 998) teaches only a method for **manufacturing/ providing an improved foundation, based on foundation piles**, the method being also disclosed as usable **to restore a subsided structure** by way injections at the base of the pile or structure of a low expansion cement-based substance (linear expansion 1-25%, corresponding to a maximum of 95% volumetric expansion.)

Kapps et al (US 4792262) discloses a process for strengthening formations in mining consisting mainly in drilling holes into the formations and filling them with a polyurethane forming foaming composition which "by virtue of its excellent adherence to coal or rock and mechanical properties strengthen the geological formations".

There are neither teachings or suggestions in Kapps et al as to using the compositions for injection in foundation soils, nor indications as to the desirability of a

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strong expansion suitable to compress the soil for improving its bearing capacities or of any monitoring system.

Haekkinen (US 4 567 708) teaches a method to level sunken, earth supported floor or slabs by injecting under the floor/slabs an expanding polyurethane forming composition which expands to fill up the voids in which the floor/slab sunk and raise it, preferably in increments.

There is in fact no teaching or suggestion in any of the cited prior art to using injection of fast expanding substances with so high expansion coefficients (at least 5 times...), deep into the foundation soil mass which is under the influence by the loads of a structure, neither there is any teaching or suggestion to perform injection process steps to improve the bearing capacity of foundation soils and to monitor the injection/expansion.

On the contrary, the prior art teaches that rapid, highly expanding substances may have a negative effect by producing breaks and fissures in the soil layers (see page 10, lines 3-8 of the specification with ref. to DE-A-33 32 256).

Objective facts regarding the possibility to combine the cited prior art and indications on the non-obviousness of the claimed invention

Clear and objective differences in, and incompatibilities between Arima and Bijsterveld et al (EP-A- 264 998), Arima and Kapps et al (US 4792262) and Arima and Schmidt et al (US 4904125), and Arima and Haekkinen (US 4 567 708), which render unsuitable, insufficient, unlikely or inconclusive the combinations of teachings available from such documents are hereinafter pointed out.

1. The basic reference teaches away from the invention

Arima teaches only lifting of buildings by use of the hydraulic pressure action of an injected cementitious substance exerted vertically, to have a jack effect on the building, the injection pressure being disclosed as an essential factor to be established as a function of the building weight (see submission at feature b above).

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The claimed invention instead is directed to increasing the bearing effect of the foundation soils by using the multidirectional chemical expansion effect of a non-cementitious, highly and fast expanding composition.

Arima teaches arranging injection points in a horizontal plane, under the foundation bottom, the number and plane distribution thereof being established as a function of the extension of the surface covered by the foundation (see submission at feature c above).

The claimed invention instead is directed to purposely locating the injection points deep into the foundation soil, i.e. away from the foundation bottom.

2. There is a lack of suggestion in the cited prior art of the desirability of modifying the basic reference or combining the references

Arima, as a basic reference, teaches to carry out a first pressure injection with a flash setting, non-expandable cementitious grout to first obtain a circular horizontal layer 31 under the bottom of the foundation and thereafter make a further injection with hydraulic pressure effect into the solidified layer to obtain a vertical jack lifting effect directly onto the bottom of the foundation.

It also teaches to possible use other compositions suitable only to have different gel times (see submissions under features a and b and the references to the other prior documents above).

Arima is completely silent as to the desirability of possibly replacing the hydraulic pressure injection method using the cementitious grout by one using a non-cementitious composition, with volumetric chemical high and fast expansion and with a lifting effect.

Thus, it is no suggestion/incentive in Arima to prompt the person skilled in the art to use for injection an expanding substance, let alone a highly expanding one and inject it

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into the foundation soil, away from the foundation bottom, to achieve a bearing capacity improvement.

This clearly shows a lack of motivation for the skilled person for such modification/combination (In re Vaek, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991; In re Linter, 458 F.2d 1013, 173 USPQ 560, 562 (CCPA 1972); Ex parte Clapp, 227 USPQ 972, 973 (Bd.Pat. App. & Inter. 1985); In re Jones, 958 F.2d 347, 21 USPQ 1941 Fed. Cir. 1992).

3. Not all the limitation of the claim are taught or suggested in the cited prior art

At least the features b) and e) are not disclosed by any of the cited prior documents.

Accordingly the claimed invention cannot be deemed obvious over the cited prior art (In re Royka, 490 F.2d 981, 180 USPQ 580 (CCPA 1974)

4. The modification of the basic reference Arima or the combination thereof with the other cited prior documents would change the principle of operation of the prior invention

Arima teaches raising subsided buildings only and only by hydraulic pressure effect of a substance injected immediately under the bottom of the foundation (see feature a-b above).

Modifying the basic reference Arima to use an (particularly a highly, fast) expanding substance, and further, to inject such an expandable substance deep into the foundation soil, would clearly change the principle of the pure hydraulic pressure effect lifting operation of the injections carried out immediately under the foundation bottom, taught by the invention of Arima.

Thus the teachings of the cited references are not sufficient to render the claims pending in the application obvious (In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959)).

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Since the other independent claims and the claims dependent thereon, pending in the application, contain or include at least the limitations of claim 15, the facts and conclusions of non-obviousness set forth above apply to all of them too.

It is eventually submitted that all of the objective facts herein represented are concordant and are consistent with the true teachings of the prior art and with the conclusions set forth.

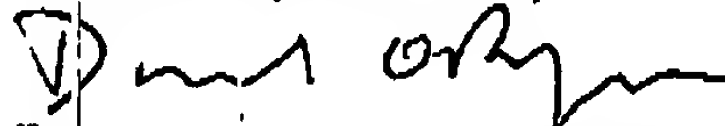
They have not been taken in isolation from disparate parts of the texts with an intention to construe a misleading argumentation.

In the applicant's view, such objective facts fully justify a reconsideration of the rejection of claims 15-35, pending in the application, and an allowance thereof.

Accordingly, it is respectfully requested that the objective facts herein submitted be thoroughly assessed by the Examiner.

Favorable action is respectfully solicited.

Respectfully submitted,



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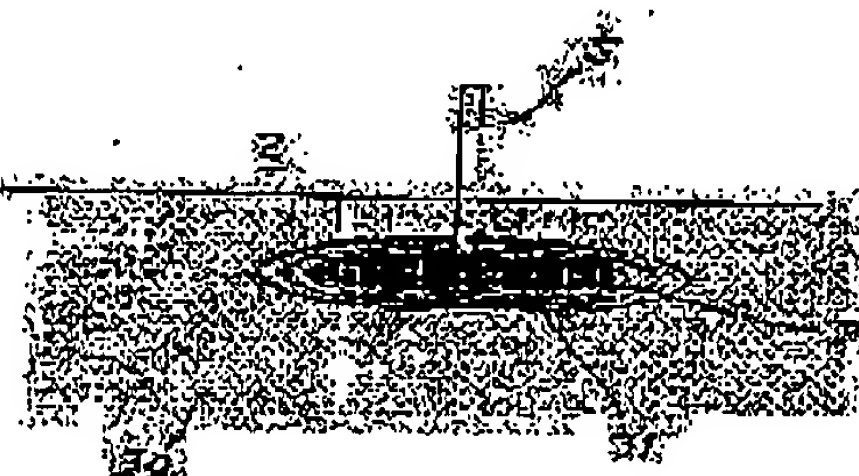
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(54) RESTORING CONSTRUCTION METHOD FOR UNEVENLY SETTLED BUILDING

(57)Abstract:

PURPOSE: To provide an economical restoring construction method in which even an unevenly settled building of great weight and having wide foundation (multistoried building) can be restored safely and easily in a short period of time, using a soil improvement technic by means of chemical injection.

CONSTITUTION: A plurality of chemical liquid injection rods 5 are set at required intervals so that an end of each of the rods is positioned in the lower part of a foundation 2 of a building to be constructed. A quick setting chemical liquid in required quantities is successively switched and forced into chemical injection points at required time intervals by means of the rods 5, and the chemical liquid is repeatedly forced into a strengthened soil layer 31 at each chemical injection point, into which chemical liquid has been injected, and into cracks of homo-gel of a chemical liquid, whereby reaction forces are gradually increased by the layer 31 so that the building together with the foundation can be raised to a normal state.



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CLAIMS

[Claim(s)]

- [Claim 1] Two or more chemical-feeding rods in a necessary spacing are installed so that the nose of cam regurgitation section may be located in the basic lower part of the purpose structure. Change ***** of the medical fluid of flash-setting nature is carried out one by one at a necessary interval with these chemical-feeding rod in each chemical-feeding part. By pressing the aforementioned medical fluid fit in the foundations which were poured in previously and strengthened in each chemical-feeding part, and the gay gel section of a medical fluid in the state of cleavage repeatedly The restoration method of construction of the differential-settlement structure characterized by raising a structure and making it restore to a normal state with the aforementioned basic section by chemical-feeding operation of increasing reaction force gradually in the concerned fraction.
- [Claim 2] The interval which changes to two or more aforementioned chemical-feeding parts one by one, and presses the medical fluid of flash-setting nature fit is the restoration method of construction of the differential-settlement structure according to claim 1 characterized by being carried out for the on-the-strength manifestation interval point in time in the on-the-strength-time curve of an injection medical fluid.
- [Claim 3] To the foundations under the basic section of the purpose structure, to the number [of necessary books] necessary depth, insert the support of a necessary length and it is fixed. Or put a load object on the basic upper part, and two or more chemical-feeding rods in a necessary spacing are installed so that the nose of cam regurgitation section may be located in the basic lower part of the aforementioned structure. Change ***** of the medical fluid of flash-setting nature is carried out one by one at a necessary interval with these chemical-feeding rod in each chemical-feeding part. Press the aforementioned medical fluid fit in the foundations which were poured in previously and strengthened in each chemical-feeding part, and the gay gel section of a medical fluid in the state of cleavage repeatedly, and reaction force is gradually increased in the concerned fraction. applying tension to the aforementioned support - or, while an upper surcharge is made to increase rather than the normal state of a structure according to the load of the aforementioned load object and consolidation strengthening of a lower stratum is promoted The restoration method of construction of the differential-settlement structure characterized by raising a structure and making it restore to a normal state with the aforementioned basic section, adjusting the tension of support, or the load of a load object.
- [Claim 4] The restoration method of construction of the differential-settlement structure according to claim 3 characterized by adjusting a load load by adjusting the amount of water in the tank while a necessary tank is used as a load object put on the basic upper part of the aforementioned structure.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention relates to the restoration method of construction of the differential-settlement structure which lifts a structure main part and carries out a return hold normally by the press force by the injection medical fluid while it presses a medical fluid fit in the basic lower part for that to which the basic section of a structure carried out the differential settlement in detail, and the structure main part inclined about the method of construction which restores the structure which mainly carried out the differential settlement and carries out strengthening enhancement of the support foundations.

[0002]

[Description of the Prior Art] If the liquefaction of a stratum generates the building with which foundations were generally built on a stratum like an alluvium by receiving the intense impact by the great earthquake etc., a support base will collapse, basic stability will be lost and it will be seen be [many] in the difficult status by the earthquake disaster of these days for the upper main part to incline from a footing and to maintain a living environment.

[0003] Although the main part intensity on a usual construction design is maintained in general, the foundations supporting a footing are spilt out by liquefaction etc., and the structure toward which such a main part inclined has the bearing value of a main part lost, it breaks down the balance and inclines. Therefore, it is not easy to restore this leaning structure (building).

[0004]

[Problem(s) to be Solved by the Invention] Usually, the lower part of the side in which the leaning structure (building) has fallen as a means considered is covered with firm beam material etc., a jack is put in between this firm beam material and the main part basic key point of a building, and a means by which a main part is gradually lifted with the jack can be considered. However, although the firm beam material is arranged to the main part basic key-point down side, since such a means must investigate foundations, it follows many distress on a preparatory work, such as needing a powerful jack moreover, with very dangerous work. Furthermore, since a jack is used, never, it raises locally and the force acts, if a large domain tends to be supported reasonable and it is going to restore, a great effort and the great time necessary for completion will be required, and workability is good. Naturally the great cost of construction starts and a problem is in economical efficiency.

[0005] Such a trouble is solved in this invention, and even if the basic section is large and is the structure (building of a multilayer story) of a large weight, using the enhancement technique of the foundations by chemical feeding, it is safely reasonable and aims at offering the restoration method of construction of the high differential-settlement structure of the economical efficiency which can be restored for a short period of time.

[0006]

[Means for Solving the Problem] In order to attain such a purpose the restoration method of construction of the 1st differential-settlement structure of this invention Two or more chemical-feeding rods in a necessary spacing are installed so that the nose of cam regurgitation section may be located in the basic lower part of the purpose structure. Change ***** of the medical fluid of flash-setting nature is carried out one by one at a necessary interval with these chemical-feeding rod in each chemical-feeding part. By pressing the aforementioned medical fluid fit in the foundations which were poured in previously and strengthened in each chemical-feeding part, and the gay gel section of a medical fluid in the state of cleavage repeatedly, it is characterized by raising a structure and making it restore to a normal state with the aforementioned basic section by chemical-feeding operation of increasing reaction force gradually in the concerned fraction.

[0007] As for the interval which changes to two or more aforementioned chemical-feeding parts in this invention one by one, and presses the medical fluid of flash-setting nature fit, it is desirable that it is made to be carried out for the on-the-strength manifestation interval point in time in the on-the-strength-time curve of an injection medical fluid.

[0008] The restoration method of construction of the 2nd differential settlement structure of this invention To the foundations under the basic section of the purpose structure, to the number [of necessary books] necessary depth, insert the support of a necessary length and it is fixed. Or put a load object on the basic upper part, and two or more chemical-feeding rods in a necessary spacing are installed so that the nose of cam regurgitation section may be located in the basic lower part of the aforementioned structure. Change ***** of the medical fluid of flash-setting nature is carried out one by one at a necessary interval with these chemical-feeding rod in each chemical-feeding part. Press the aforementioned medical fluid fit in the foundations which were poured in previously and strengthened in each chemical-feeding part, and the gay gel section of a medical fluid in the state of cleavage repeatedly, and reaction force is gradually increased in the concerned fraction. While an upper surcharge is made to increase rather than the normal state of

a structure according to the load of the thing for which tension is applied to the aforementioned support, or the aforementioned load object and consolidation strengthening of a lower stratum is promoted. It is characterized by raising a structure and making it restore to a normal state with the aforementioned basic section, adjusting the tension of support, or the load of a load object.

[0009] Moreover, in order to promote consolidation strengthening of the basic lower stratum of a structure, while a necessary tank is used as a load object put on the basic upper part of the aforementioned structure, it is good to adjust a load load by adjusting the amount of water in the tank. Moreover, as for the aforementioned support, it is good that it is bowed and planted in the foundations under a footing from the basic upper part of a structure to a necessary depth, carry out hardening fixation of the point of this support with a medical fluid, and a load is added more than the amount of self-weights of a structure by jack equipment in the basic upper part at the basic section of the aforementioned structure. In addition, as for this support, it is desirable that it is prepared in two or more places at the necessary spacing in the basic section of the purpose structure, and the press force is added to the pars profunda of the foundations under a footing on the average.

[0010]

[Function] According to the restoration method of construction of the differential-settlement structure of such this invention 1st, to the basic subordinate of the structure which inclines by the differential settlement. By repeating operation of changing a chemical-feeding part and pouring in the medical fluid of flash-setting nature one by one at a necessary interval to the basic subordinate of the side in which especially this structure has fallen from each chemical-feeding rod inserted in two or more places at the necessary spacing. The gay gel section of the foundations which were poured in previously and strengthened, and an injection medical fluid cleaves, the pressing reaction force of a medical fluid increases gradually, and the aforementioned structure is raised with the basic section. therefore, a load [push up / the rigidity of the basic section of the purpose structure, the rigidity of a strap, or a structure / arrangement of the transfer pressure of a medical fluid, the amount of injection, and an injection part etc. and] -- ** -- it can be alike and can make it restore normally easily [it is reasonable and] for a short period of time to make it correspond.

[0011] Thus, by adopting the method which takes a necessary interval and pours in change ***** one by one in two or more injection parts, the reaction force increase function in each concerned injection part will be raised uniformly. Therefore, even if the inclination status and its height, the construction area, etc. of a structure differ from each other, according to the status, arbitrary correspondence of the number of chemical-feeding parts, a transfer pressure, the amount of injection of an injection medical fluid, etc. can be adjusted and carried out, it has by a setup and its chemical-feeding work of chemical feeding, and restoration work can be carried out for a short period of time.

[0012] If it is in the method of construction of this invention, it is taking the interval of a chemical-feeding change in each injection position in multipoint (two or more places) change injection operation of a medical fluid at the on-the-strength manifestation interval time in the on-the-strength-time curve of the injection medical fluid. By obtaining time being in the status that it can cleave in part by the transfer pressure of the medical fluid poured in later, the accretion section which is poured in previously and formed can pour in the medical fluid of repeat flash-setting nature, and can attain the desired end easily.

[0013] Moreover, according to the restoration method of construction of the differential-settlement structure of this invention 2nd, insertion fixation of the support is carried out from the basic upper part of the leaning structure even on the strong foundations under this basic section. By putting a load object (heavy lift) on the basic upper part, and a load being added more than the amount of self-weights of the concerned structure, or it has in this support by the thrust by devices, such as a jack, and it makes the tonus force add. By reducing gradually the aforementioned load (the tensile force applied to support, or weight of a load object), the basic section raising and making it balance to the status, while the same operation as the 1st aforementioned invention is performed. For example, when construction foundations are compressive strata like a cohesive soil layer like a silt layer, early consolidation strengthening of the stratum of the accretion subordinate by the above-mentioned chemical-feeding operation is promoted. Consequently, even if it is foundations like a compressive cohesive soil layer, it may be combined in the effect that phenomena, like a structure inclines again by the bottom of precipitation can be prevented beforehand.

[0014]

[Example] Next, the one example is explained about the restoration method of construction of the differential-settlement structure of this invention, referring to a drawing.

[0015] Drawing which expresses typically the mode which restores the building which inclined by the restoration method of construction of the differential-settlement structure of this invention is shown in drawing 1. (a) It is shown that a building is in a normal state and it is (b). It is shown that foundations carry out a differential settlement and the building leans, and it is (c). The mode which carries out construction start of the method of construction of this invention is shown, and it is (d). The mode to which the building was normally restored by the chemical-feeding operation by the method of construction of this invention is being shown. Drawing 2 is a plan showing two or more chemical-feeding parts which receive the basic lower part of the building shown in drawing 1, and the piping mode of those injection. Drawing 3 is an important section cross section which expresses typically the mode which is adding injection operation of a medical fluid. Drawing 4 is drawing which illustrates the chemical-feeding permission time in the on-the-strength-time curve of an injection medical fluid.

[0016] As shown in these drawings, the method of construction of this invention carries out the investigation grasp of the status (refer to drawing 1 (b)) of the building 1 which inclined first, and examines the optimum work means. In this case, a future working state is set up according to the foundations 30 and the construction status of a footing 2 that the leaning building 1 is supported.

[0017] First, foundations 30 are incompressible soil layers, for example, a stratum like a sandy layer, and a means to restore

the building 1 which is expressed in the aforementioned view "raft foundation" is explained.

[0018] The most desirable one performs injection work of a medical fluid from the interior of a building 1. In this case, relations, such as a presumed weight of a basal-plane product and a structure (the building 1 and footing 2), the rigidity of a raft foundation, and the rigidity of a strap, are taken into consideration, and the number and arrangement spacing of an insertion part of the chemical-feeding rod 5 are set up. Therefore, if the presumed weight of a structure is moreover size, as the burden of one chemical-feeding rod does not become excessive, it will be used mostly, a basal-plane product will be large, the rigidity of the basic section will be size enough, a basal-plane product is conversely small, if the presumed weight of a structure is smallness, there will be few arrangement books of the chemical-feeding rod 5, and it will end. Moreover, if the rigidity of the basic section is smallness, it is made to correspond to the target statuses of a structure, such as making many] the number of arrangement books of the chemical-feeding rod 5, and making a medical fluid pour in more nearly gently than the former etc.

[0019] The rod of the well-known double-pipe structure of having the mixed injection section of A liquid of a medical fluid and B liquid is used for the chemical-feeding rod 5. And at the necessary spacing (about [Usually about 2] m), this chemical-feeding rod 5 makes the footing 2 of a building 1 penetrate, and two or more are inserted to the foundations 30 of the basic lower part so that it may be illustrated in drawing 2. In this case, it is desirable to be allotted so that the point of the chemical-feeding rod 5 may be inserted to the basic section bottom and the lifting applied force by injection (pressing fit) of a future medical fluid may work on the basic 2 inferior surface of tongue of *****. Moreover, it is desirable to sample a stratum in the contiguity section of a structure, although the status of foundations 30 is presumed beforehand.

[0020] If the chemical-feeding rod 5 is arranged to two or more places at intervals of necessary, the supply pipes 12 and 13 of A liquid and B liquid (hose etc.) will be piped by each [these] chemical-feeding rod 5 from the high pressure pumping of the medical fluid supply unit 10 through the change bulb 11, respectively.

[0021] As an injection medical fluid dealt with here, it is a mixture of soda as A liquid, for example. 50l., water Considering the thing of the rate of 50l. ** as 100l. and B liquid, it is cement. 60kg, plaster 20kg, water The gelation times by which make the thing of the rate of a residue 100l. and mixed injection is carried out at a rate of 1:1 are about 3 secs. The grout of flash-setting nature is used. In addition, about the component of this medical fluid, the thing of a component suitable for not being specified as the above-mentioned component but changing a gelation time is employable.

[0022] Moreover, such a medical fluid is 2 about 30-100kg/cm² by the high pressure pumping of the chemical-feeding operating set 10. They are 10-20l. / min at a pressure. It is supplied by the flow rate of a grade. And about the aforementioned transfer pressure, the presumed weight of the purpose structure is light and foundations can attain the purpose by the injection in low voltage in the status of a sandy layer that an injection speed is comparatively early. About the amount of injection in this case, if it is also possible to take the environment of the periphery of a structure etc. into consideration, and to pour in mostly and many amounts of injection can be taken, restoration operation can be performed by the short time necessary for completion. It is necessary to raise a transfer pressure, and when the presumed weight of a structure is large, with such conditions, conversely, the amount of injection may also be inversely proportional to it, and may decrease. Anyway, it will be chosen according to the status of the purpose structures, such as foundations, and the optimum conditions will be set up, performing restoration work.

[0023] In case of chemical feeding, the chemical-feeding rod 5 is inserted and installed in the hole first excavated previously toward the cobblestone layer of these basic lower foundations 30 etc. from the top of a footing 2 to a necessary depth. When the chemical-feeding rod 5 is installed, it is fed through the supply pipes 12 and 13 with which the above-mentioned flash-setting nature medical fluid (A liquid and B liquid) was beforehand connected to this chemical-feeding rod 5, it is mixed in the nose of cam mixture section of the concerned chemical-feeding rod 5, and is poured in in the earth.

[0024] the number corresponding to the basic section at large which generally requires the injection part by the aforementioned chemical-feeding rod 5 for restoring the purpose structure (building 1) at intervals of about 2m (it not being limited to this and you being a larger spacing or a narrow spacing in consideration of the rigidity of the basic section.) -- it is arranged in two or more places in an appropriate array And it changes at a necessary interval by the remote control which does not have the change bulb 11 illustrated, and A liquid and B liquid are supplied to each chemical-feeding rod 5 of these chemical-feeding part by the high pressure pumping of the aforementioned medical fluid supply unit 10 at a necessary rate from the medical fluid supply unit 10 separately installed in the location.

[0025] It is the interval set up beforehand, for example, the supply sequence over the chemical-feeding rod 5 of each chemical-feeding part is the 2nd, the 3rd, and the 4th one by one from an injection part at the very end to the adjoining chemical-feeding part. The amount of supply of this medical fluid is performed by for example, the aforementioned medical fluid considering 10-20l. / min, and an injection switching interval as abbreviation 10sec-2min (the geology of foundations, a presumed weight, a basal-plane product of a structure, etc. are taken into consideration, and selection change is carried out according to the progress status of work).

[0026] thus, since the medical fluid of flash-setting nature poured in first will not receive strong resistance at all in underground in the 1st time of the as shown by drawing 3 ** if a medical fluid is poured in, it centers on an injection position in the domain until it gels -- it is spread around almost circularly and joint condensation is carried out with earth and sand In this case, condensation starts at the same time it mainly diffuses; an injection medical fluid horizontally from the regurgitation edge of the chemical-feeding rod 5, and it is spread, since the gelation time is about 3 seconds. Therefore, the early amount of injection is predicted beforehand, and if injection of the amount of schedules finishes, it will change to the next injection part immediately, and will pour into an adjoining position. It does in this way below and a medical fluid is poured into all injection parts requirements every. In the earth of such operation, the solidified almost circular accretion layer 31 of a medical fluid and earth and sand is formed for every injection part. If a medical fluid is poured in in the earth,

since sand granules are having the stratum formed in the incompressible status, a medical fluid permeates among these sand granules, adhesion condensation is carried out at the peripheral surface of sand granules, the domain which committed adhesives so to speak and permeated will be strengthened with the stratum of a sandy layer as hardening field of one group, and stable strengthening **** will be formed in it.

[0027] When coming to the midpoint of the process in which the accretion layer 31 in the injection part poured in first discovers a predetermined intensity in connection with the reaction of a medical fluid soon, the aforementioned medical fluid is again poured in from the chemical-feeding rod 5. In this status, the medical fluid poured in previously as mentioned above reacts, although gay gelation is carried out (refer to the drawing 4), since the intensity is still 1/2 or less [in a stability range], it cleaves in a part of accretion layer 31 from the nose of cam of the chemical-feeding rod 5 by the pressure which acts on the medical fluid poured in, and a medical fluid is pressed fit toward the near from this accretion layer 31 interior.

[0028] Then, unlike the time of the above early injection, the medical fluid pressed fit will receive the limit which can mainly flow to this accretion layer 31 up side in the flow prevention operation to the bottom by the accretion layer 31 currently previously formed with the load of the earth pressure force and structure which work on foundations 30, and will be pressed fit by the pressure which overcomes the load of the aforementioned earth pressure force and a structure. Consequently, in general, it will mainly be horizontally spread in the strengthening section which is not hardened, and the medical fluid pressed fit becomes a film along the interior of the upper layer of the accretion layer 31, a diffusion flow of it will be carried out and the transfer pressure of a medical fluid will accumulate it in the state of the liquid in within the limits (gay gel) of the gelation time. In this case, since the sandy layer which forms foundations 30 as mentioned above is incompressibility while the accretion layer 31 is presenting the status that it was already fixed all over foundations 30, the stratum of the domain top which the reaction force of the pressure accumulation force by the aforementioned medical fluid acted, and the medical fluid to accumulate diffused will be made this accretion layer 31. The accretion layer 31 is expanded gradually simultaneously (refer to drawing 1 (c)).

[0029] By the injection (pressing) of a medical fluid performed at the aforementioned interval one by one in each chemical-feeding part where such an operation was arranged, the stratum on the every place board strengthening layer 31 will be raised gradually. Therefore, while each chemical-feeding part is repeated in order, it continues at a necessary interval and the above-mentioned chemical-feeding operation is performed, it adjusts so that it may distinguish between operation with the large domain of the sinkage of a upside structure, and a few domain according to the elevation status of a stratum and the injection (pressing) operation part may be gradually raised from the large fraction of a sinkage. By doing in this way, the basic section among which the structure which inclined according to the height in which the continuous foundations 30 centering on these chemical-feeding part upheave gradually, and the foundations 30 upheave is sinking goes up. The amount of elevation of the structure of the fraction which was sinking with the surveying instrument implement is beforehand measured with progress of work, or the level of the floor line of a building is measured, and injection work of the aforementioned medical fluid is continued until it returns to the normal status.

[0030] constructing as mentioned above -- drawing 1 (b) - (d) The stable maintenance of the foundations 30 which the footing of the structure normally restored from the inclination status supports is carried out, without receiving the depression phenomenon in a flow of the foundations 30 yoke by chemical feeding, simultaneously the earth and sand by the liquefaction of foundations 30 even if enhancement strengthening of will be done, stable support will be carried out in a large area and it is again hit by the earthquake so that it may be shown. In addition, it is possible to operate the OP beforehand set as a control means to attach changeover operation of an injection position, a management of injection time, adjustment of the amount of injection, adjustment of a transfer pressure, etc. to the medical fluid supply unit 10 in the restoration operation by the above-mentioned chemical feeding, and to operate it automatically with the combination of an operator and autonomous working. If it does in this way, even if it needs many helps for a preparation setup, the time necessary for completion can be shortened by automating restoration operation, and economical efficiency can be raised.

[0031] Although the above explanation described the restoration method of construction of the differential-settlement structure by chemical feeding in a building of a "raft foundation" In the case of the structure of structure (generally called the mat foundation) which allotted the footing to a part for the lower part of the main part support cylinder of a structure The chemical-feeding rod 5 can be installed from the exterior of a structure etc. by two or more places like the above-mentioned to the foundations 30 of the aforementioned basic section, and the structure which inclined by carrying out operation which repeats injection (pressing) of a medical fluid one by one in the above-mentioned and this way to each [these] chemical-feeding rod 5 can be restored.

[0032] Next, the restoration method of construction of the differential-settlement structure of this invention 2nd is a method of construction which can carry out the restoration maintenance of the structures, such as the building 1 which is built on stratum 30a which foundations 30 become from cohesive soil mainly like a silt layer, and inclined, effectively, as shown in drawing 5. By this restoration method of construction, operation of adding a pressure to compressive stratum 30a of the foundations 30 where a structure footing is supported, and promoting consolidation strengthening can be used together.

[0033] this restoration method of construction -- first -- the underground from the lower footing (in this example, it is the so-called "raft foundation") of a building 1 -- it is a necessary spacing, and two or more support 20 which excavates to a base rock, the grit layer 35, etc. if it can do -- deeply, and becomes with a metal rod is suitably driven in by the distribution according to the basal-plane product, and the point 21 of these support 20 is fixed in the earth with the medical fluid 5 of flash-setting nature In addition, it connects by the well-known means on the way if needed, and this support 20 is connected with one.

[0034] Make the upper-limit section 22 of this support 20 project on a footing, it makes reaction force received in the firm block 25 laid on the basic section 4, and makes moderate tensile force add with a jack 26 (for example, hydraulic jack) with a well-known means. It sets after that and the insertion installation of two or more double juxtaductal type chemical-feeding

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rods 5 in a necessary spacing (about 2m) is carried out from the basic section 4 like the above-mentioned (based on the 1st invention) to the down side, and it is piped by each through the change bulb which is not separately illustrated by each these] chemical-feeding rod 5 from the medical fluid supply unit (not shown) of an installation, and carries out supply-pressure close [of the same medical fluid as the above] at the necessary interval in the aforementioned point [0035] By injection operation of this medical fluid, the accretion layer 31 into which the repeat medical fluid was injected as mentioned above is formed, a building 1 is lifted one by one by the accretion layer 31 with the basic section 4, and the inclined structure is gradually restored normally to the foundations 30 under the basic section 4 by the pressure accumulation operation by the medical fluid poured in (pressing). In this case, if the structure (building 1) of the status connect with the depths section with the above-mentioned support 20 is depended and made the above-mentioned medical fluid pressing and it is restored up by operation, still strong tensile force will act on the support 20. Consequently, the aforementioned foundations 30 hardening layer supporting the basic section of a structure presses the compressive stratum 30a like the silt layer in foundations 30, a compression operation of a stratum arises in the press fraction, and the early consolidation of the concerned compressive stratum 30a is promoted.

[0036] If the restoration method of construction of the differential-settlement structure of this invention 2nd is enforced by such means, at the time of inclination restoration operation, compressive foundations 30a will be improved simultaneously, depression of the foundations 30 which will be generated in the long period of time is prevented, stabilization of foundations can be attained, and there is an effect that the influence on the structure main part by the differential settlement etc. can be prevented beforehand. Of course, about the operation which pushes up the basic section which enhancement of foundations 30 and the above-mentioned stratum were upheaved, and sank, it is the same as that of the 1st aforementioned invention, and trouble is not caused to the workability at all.

[0037] It can replace with the method of support 20 use in the restoration method of construction of the differential-settlement structure accompanied by consolidation strengthening of the aforementioned compressive stratum 30a, and water can be filled and used for a tank as an upper surcharge added to a structure. It arranges on the basic top of a structure so that water may be poured into a well-known tank and it may become a necessary weight as this tank. And adjusting the upper surcharge to a footing can be easily performed by emitting the water in a tank gradually in the elevation process in which a building is lifted with a footing by the above-mentioned chemical-feeding operation. Therefore, according to this method, although the installation space of a tank is needed, since digging like a support method and thick work of support are not required, workability becomes easy.

[0038] Moreover, it faces enforcing the restoration method of construction of the differential-settlement structure of this invention, and there is a possibility of penetration of a medical fluid arising by the diffusion of the medical fluid in the inside of foundations around an injection part, and upheaving foundations in the parvus fraction of the load to foundations in connection with the above-mentioned chemical feeding according to the environment of the work site. Therefore, *****'s is desirable in a means to prevent that drive a vertical sheeting (sheet pile) into the neighboring position of the purpose structure to a necessary depth before carrying out the above-mentioned restoration work beforehand, and a medical fluid flows out of an injection position in addition to the foundations under a structure footing. Moreover, the restoration operation by chemical feeding can be effectively carried out by doing in this way.

[0039] As stated above, according to this invention, time is suitably poured in for the medical fluid of flash-setting nature into a stratum repeatedly. Form in a large domain the accretion layer by which solidifies in a **** short time and the consolidation was carried out in the earth, and to compression, the formed accretion layer is strong and uses weak physical properties for ** to tension. By operation which changes an injection position one by one by the necessary rotation in the interval of short time Heap up, carrying out increase formation of the accretion layer gradually, and hardening foundations gradually, and reaction force is made to act on a powerful accretion layer one by one, an injection fluid pressure can be distributed over a large domain, the pressure accumulation force of liquid can be raised, larger climbing power can be obtained, and a structure can be raised rationally reasonable. Therefore, the upward force with a structure impossible for does not act, but the desired end can be attained comparatively for a short time.

[0040] [Effect of the Invention] It is [of it being able to restore safely, without an inequality structure upward force acting, since it is the technique of raising the construction foundations of a structure gradually from the interior of a stratum, and restoring as mentioned above according to the restoration method of construction of the differential-settlement structure of this invention, and the need of the work which applies big external force to a direct structure also about a preparatory work not being carried out, but ending / of a work top being also safe and there being also little cost of construction / carrying out economical effect work] a potato Moreover, since the target structure is employable regardless of size, it can demonstrate a tremendous effect to a restoration of a large building especially.

[0041] Moreover, it is ***** , when the depression accompanied by the secular change in compressive foundations can be prevented simultaneously and it is a more effective method of construction by carrying out support juxtaposition work.

[Translation done.]

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